Space Weather Technical Forecast

Issued on Tuesday, 11 June 2024 at 00:18 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-flares (R1-R2 radio blackouts) initially likely, slight chance of X-flares (R3 blackout), risk declining through the period. Chance of minor solar radiation storm (S1-S2) initially, risk declining through the period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is High with an X1.5 flare peaking at 10/1108 UTC from AR3697 on the southwest limb. There are currently eight sunspot regions on the visible disc. The most active region is AR3697 which has now rotated off the southwest limb and is no longer clearly visible. It will continue to contribute to the flare risk for another 24 hours or so until it is well away from the southwest limb. AR3709 in the southeast is now the largest region on the disc. It consists of a large leader spot with smaller spots around it. The remaining sunspot regions are mostly simple and stable. Some looping observed in SDO imagery suggests a new region to rotate onto the southeast limb in the next 24 hours.

A CME which left the Sun on 08 June arrived at L1 10/1635 UTC, much later than anticipated, with an arrival observed at STEREO-A (ahead of Earth's orbit) at 10/0300 UTC, therefore it appears Earth may have observed the tail end of the CME as it passed. No new Earth-bound CMEs were observed in the last 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by ACE at L1, were at background levels initially, before the arrival of the aforementioned CME (which left the Sun on 08 June), with speeds reaching slightly elevated to elevated levels, near 500km/s. Density was below average initially, before increasing to above average, peaking at 17ppcc at 10/1646 UTC due to the CME arrival. The IMF (Interplanetary Magnetic Field) was weak at 6nT or below initially, but increased to reach a peak of 16nT with the arrival of the CME, with the north-south component, Bz, initially weak, but peaked at -11nT at 10/1650 UTC. The phi angle fluctuated a little but was mainly positive (away from the Sun). Geomagnetic activity was Quiet (Kp 1 to 2) initially, increased to Unsettled to Active (Kp 3 to 4) from 10/1500-2100 UTC due to CME influence.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 continued to ease below the S1/Minor radiation storm level.

High energy electron flux (greater than 2MeV) observed by GOES16 was at background levels, with the associated 24-hour fluence well below Active. Observed fluence at 11/0000 UTC was 1.15e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: M-flares are initially considered to be likely with a slight chance of further X-flares, mainly from AR3697, which has rotated off the disc, but could still contribute to the flare risk. The risk reduces through Day 1 (11 June) as AR3697 continues to rotate away from the west limb.

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Solar Wind / Geomagnetic Activity: The CME (which left the Sun on 08 June) arrived at the STEREO-A spacecraft at 10/0300 UTC, with most likely the tail end of the CME arriving at Earth later than anticipated at 10/1635 UTC. Solar winds have recently increased to slightly elevated levels due to the CME influence. Solar winds are expected to gradually decline to background levels during day 1 (11 Jun). A further slight enhancement is possible from the small CH44/- in south centre disc later on Day 3 or early Day 4 (13-14 June).

Geomagnetic activity is likely to be Unsettled or Active at first, due to the influence of the CME, which arrived late on 10 Jun, with a slight chance of G1/minor storm early Day 1 (11 Jun) if any prolonged negative Bz is observed. Mostly quiet conditions are likely on Day 2 (12 Jun), with a slight chance of Unsettled to Active intervals later on Day 3 and Day 4 (13-14 Jun) due to any weak high speed stream influence from CH44/-.

Energetic Particles / Solar Radiation: High energy proton flux is now below S1/Minor radiation storm levels after the recent S3/Strong enhancement. A reducing risk of further S1 or S2 radiation storms as AR3697 continues to rotate away from the southwest limb in the next 24 hours.

High energy electron flux is forecast to persist at predominantly background levels, and the associated 24-hour fluence forecast should remain below the Active threshold.

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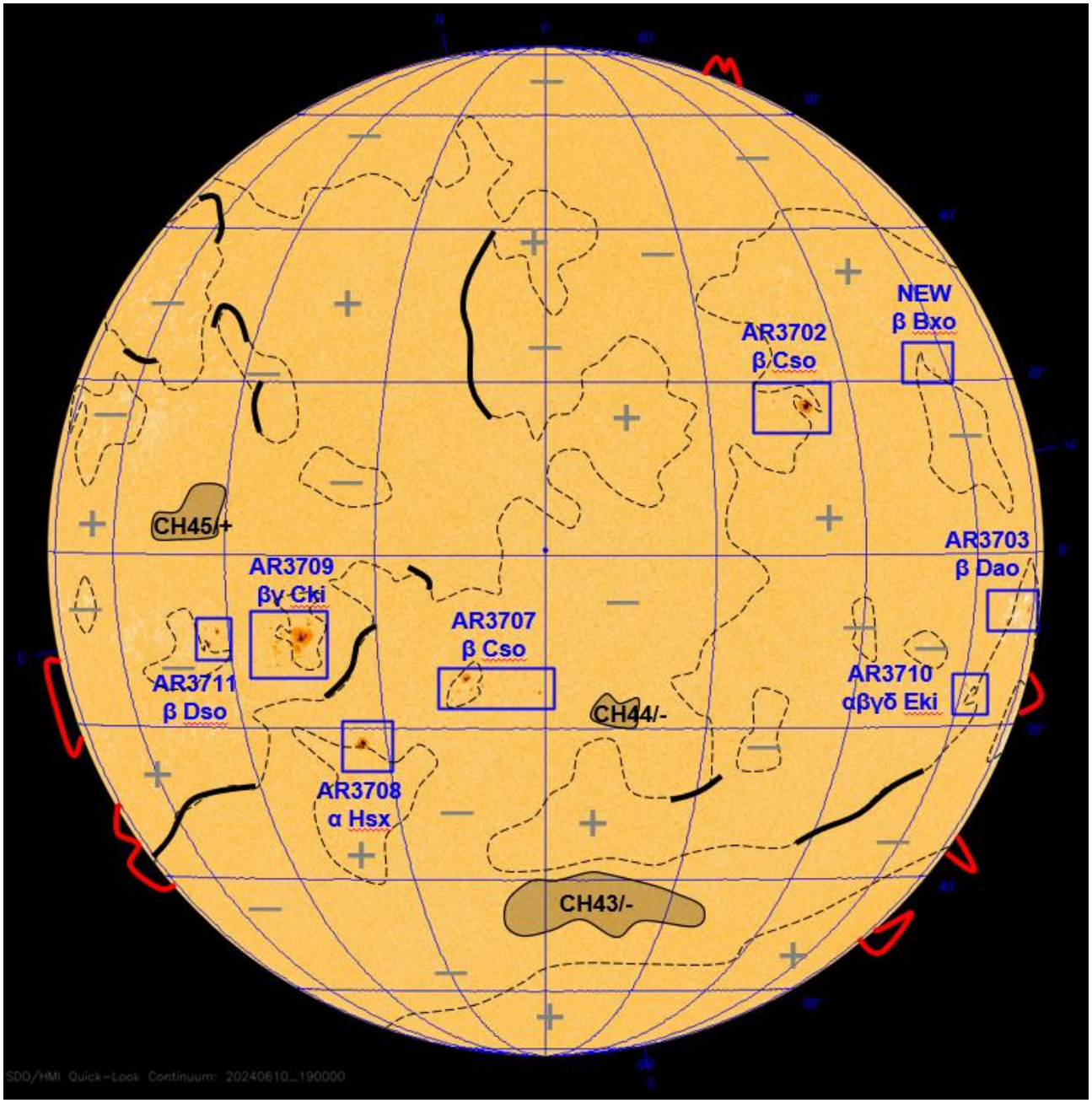
Figure 1. Solar Analysis Valid 10/1900 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:
The M9.7 flare from AR3697 at 08/0149UTC in the southwestern disc generated a CME which was modelled by MOSWOC Enlil with a likely arrival time at Earth in the UTC morning of 10 June. Most of the ejecta was directed south and west of the Sun-Earth line, although the CME was observed to arrive at the STEREO-A spacecraft at 10/0300 UTC. However, the expected arrival of this CME at Earth (early on 10 June) didn't materialise until much later in the day, observed arriving at L1 at 10/1645 UTC. STEREO-A is currently located slightly inside of and ahead of Earth's orbit, therefore, it is considered that Earth caught the tail end of the CME as it was passing.

No other new Earth-directed CMEs have been seen in available coronagraph imagery.

Solar winds are currently slightly elevated to elevated levels, near 500km/s, due to the arrival of the CME (from 08 June), which expected to gradually ease to background levels on Day 1 (11 June) as the influence of CME wanes. A further slight enhancement is possible from the small CH44/- in south centre disc later on Day 3 into Day 4 (13-4 June). However, this is expected to be minor and with a limited geomagnetic response, given the time of year.

Geomagnetic activity is likely to be Unsettled or Active at first, due to the influence of the CME, which arrived late on 10 Jun, with a slight chance of G1/minor storm early Day 1 (11 Jun) if any prolonged negative Bz is observed. Mostly quiet conditions are likely on Day 2 (12 Jun), with a slight chance of Unsettled to Active intervals later on Day 3 and Day 4 (13-14 Jun) due to any weak high speed stream influence from CH44/-.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	1	5	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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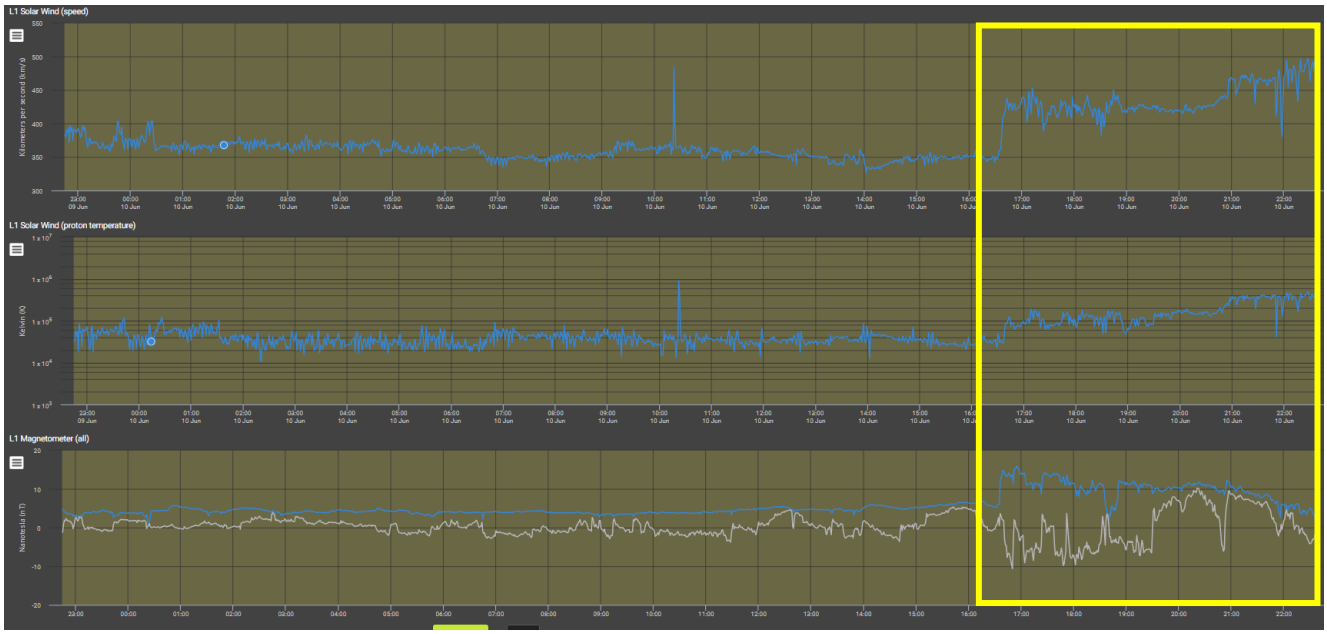
Figure 2: Data from L1/ACE spacecraft shows the arrival of the CME (yellow box) at Earth (which left the Sun on 08 June). This arrived later than anticipated, with an early arrival at STEREO-A (10/0300 UTC), therefore, its suggested that Earth caught the tail end of the CME as it passed.



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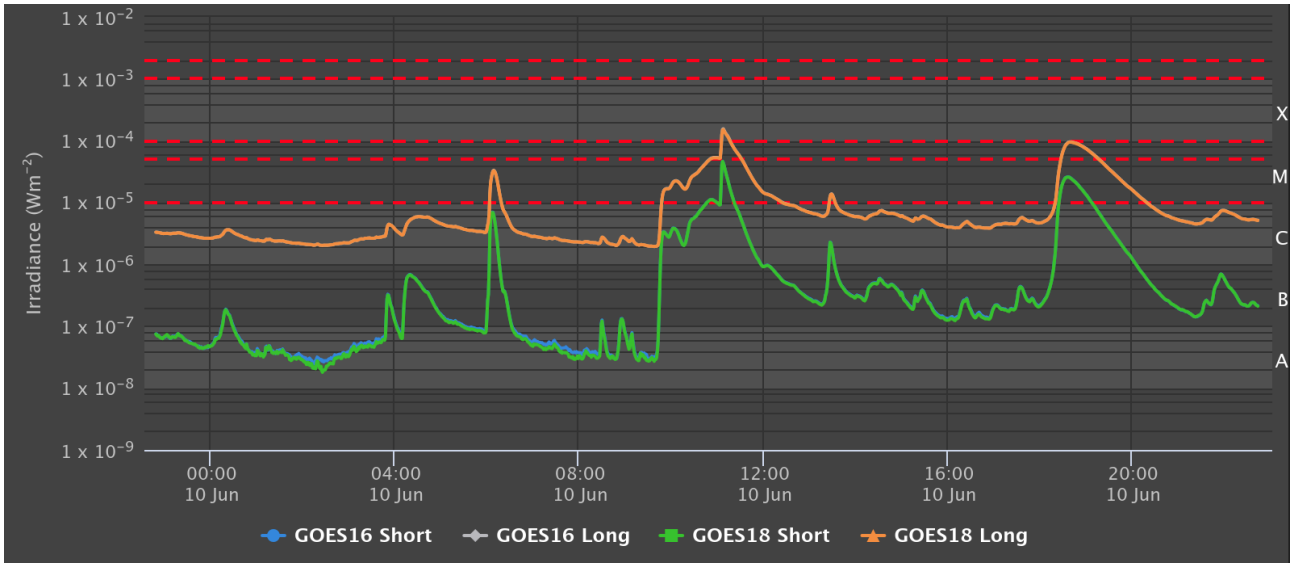
Radio Blackouts - X-Ray Flares:
Solar activity is High with an X1.5 flare peaking at 10/1108 UTC from AR3697 on the southwest limb.

There are currently eight sunspot regions on the visible disc, with a new region developing in the northeast. The most active region is AR3697, but this has rotated off the southwest limb and is no longer clearly visible. It will continue to contribute to the flare risk for another 24 hours or so until it is well away from the southwest limb. AR3709 in the southeast is now the largest region on the disc. It consists of a large leader spot with smaller spots around it. The remaining regions are mostly simple and stable at the present time. Some looping observed in SDO imagery suggests a new region to rotate onto the southeast limb in the next 24 hours.

M-flares are initially considered to be likely with a slight chance of further X-flares, mainly from AR3697, which has rotated just beyond the southwest limb, so it's still in a prime location. The risk will continue to reduce through Day 1 (11 June) as AR3697 rotates away further away from the southwest limb.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	30	20	10
Very Active	R3 to R5 X Class	Yes	15	5	1	1

Figure 3: GOES X-Ray flux trace, shows the recent X-flare from the departing AR3697.



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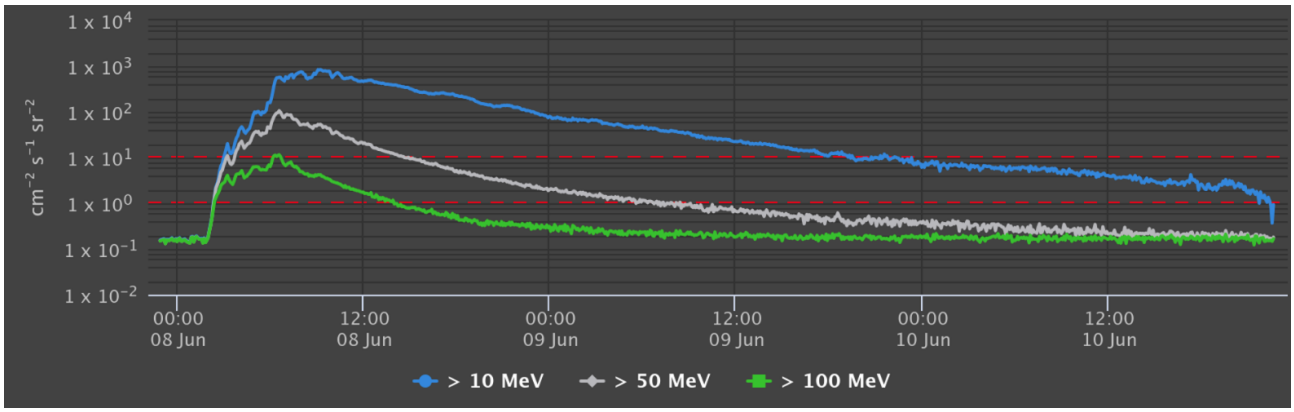
Solar Radiation Storms - (High Energy Protons):
AR3697 is currently in a prime position to deliver further S-scale enhancements. The recent X-flare from this region means that it is likely proton flux will once again reach above S1, with a slight chance of reaching S3, during the next 24 hours or so. The risk from this region then reduces once it rotates well away from the west limb, during Days 2-3 (12-13 June).

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	50	20	5	1
Very Active	**≥ S3 ***	No	10	5	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 4: Proton flux at GOES-18 over the last three days, showing the enhancement on 08 June and the gradual subsequent decline.



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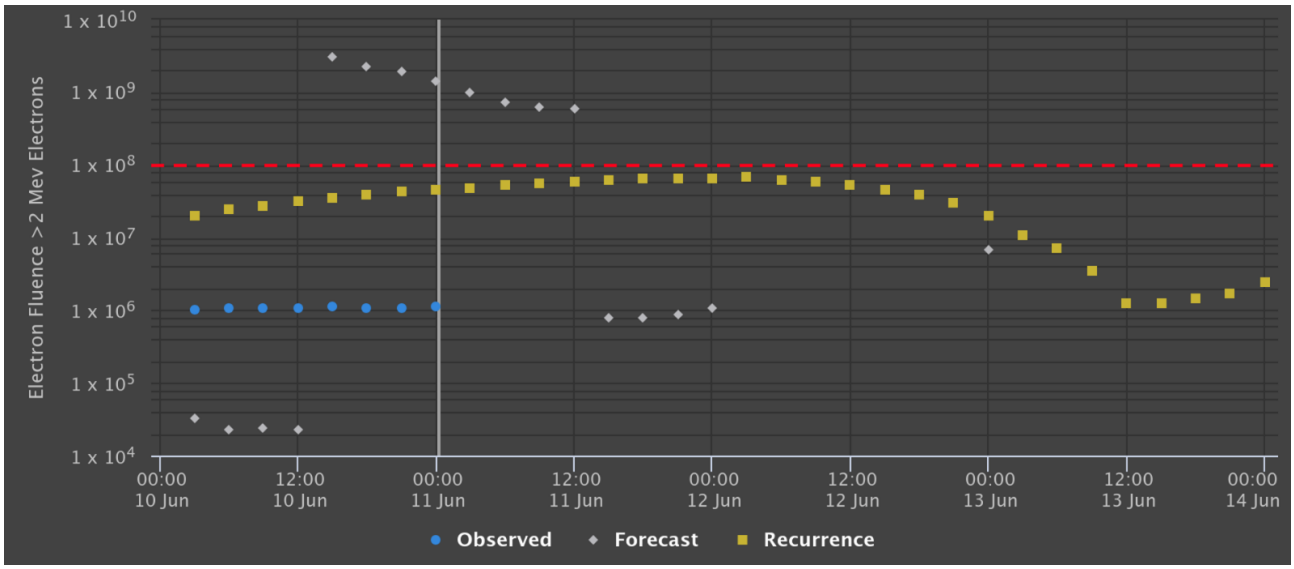
High Energy Electrons Event (≥ 2MeV):
The high energy electron flux is likely to persist at background levels for much of this period.

MOSWOC REFM output has been forecasting an increase in fluence above the Active (1e8 integrated pfu) level in the next 24 hours, but this appears unlikely to occur, with fluence expected to remain below Active through this period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: MOSWOC REFM electron fluence.



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